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ABSTRACT

This study followed Sternberg and Horvath's (1995) prototype view to sketch a teaching expertise schema as the hypothetical model. An interview of 13 novice, beginning, and expert teachers was used to examine the adequacy of the model. The participants were asked to comment on slides of classroom events. Their think-out-loud protocols were coded using two coding systems (knowledge domains and levels of processing). Then, their active pedagogical knowledge was drawn for further content analysis using quantitative and qualitative methods. Results indicated the appropriateness of the hypothetical model to treat experts' knowledge as the prototype of teacher expertise. However, significant differences existed between novice, beginning, and expert teachers' knowledge, so some modifications (e.g., fuzzy nature, knowledge element features, weights of subdomains, and knowledge organization) were recommended. Expert teachers possessed more knowledge than beginning and novice teachers. (Contains 26 references.) (Author/SM)

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Looking for the Prototype of Teaching Expertise: An Initial Attempt in Taiwan*

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schemata (cognition), cognitive process, teacher cognition, teacher knowledge, student teachers, master teachers, preservice teacher education

Abstract

This study follows Sternberg and Horvath's (1995) prototype view to sketch a teaching expertise schema as the hypothetical model. An interview of thirteen novices, beginners, and experts was used to examine the adequate of the hypothetical model. The participants were asked to comment on slides of classroom events. Their think-out-loud protocols were coded using two coding systems, i.e. knowledge domains and levels of processing. Then their active pedagogical knowledge was drawn for further content analysis by quantitative and qualitative methods. Results indicated the appropriateness of the hypothetical model to treat experts' knowledge as the prototype of teaching expertise. However, significant differences existed between novice, beginning, and expert teachers' knowledge, so some modifications, i.e. fuzzy nature, knowledge element features, weights of subdomains, and knowledge organization, were recommended.

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Introduction

Studies of expert teachers have attracted considerable research interests in recent years, though there is still no common agreed definition of teaching expertise. That the criteria of selecting expert teachers varied among studies has demonstrated such diversity and confusion. Sternger and Horvath (1995) suggested a prototype view to reveal teaching expertise. They suggested, first, to group teachers into categories along a continuum of expertise. Then a prototype of the expert teacher category can be thought of as the shared features among all valid members. If one searches for the similarity among expert teachers' pedagogical knowledge, a sound base of teaching expertise can be constructed gradually.

Expert-Novice Research

One way to understand what an excellent teacher knows is to compare expert with novice teachers' behaviors and cognitive processing. Results from the expert-novice research (Borko & Livingston, 1989; Leinhardt, 1989; Leinhardt & Greeno, 1986; Livingston & Borko, 1989; Perterson, 1988; Peterson & Comeaux, 1987; Strahan, 1989; Swanson, O'Connor, & Cooney, 1990; Westerman, 1991; Wintzky, Kauchak, & Kelly, 1994) showed that expert and novice teachers see classroom events differently because they know differently. The knowledge that expert teachers bring into classrooms allows them to infer accurately and efficiently, to screen irrelevant information, and to comprehend the meaning behind classroom activities.

Berliner and his colleagues (Carter, Sabers, Cushing, Pinnegar, & Berliner, 1987; Carter, Cushing, Sabers, Stein, and Berliner, 1988; Saber, Cushing, & Berliner, 1991) found that expert teachers performed better at: 1) monitoring and comprehending classroom events, 2) interpreting instructional strategies, 3) hypothesizing reasons for behaviors, and 4) offering solutions for classroom problems. Expert teachers' excellent performance could be accounted for by their knowledge structure and reasoning skills. These researchers assumed that expert teachers' pedagogical schema was relatively more elaborate, interconnected, organized, and accessible than that of novices.

Teacher Knowledge

What kinds of knowledge do expert teachers possess in order to achieve excellence? First of all, expert teachers must be well versed in their subject matter: this is content knowledge. To perform excellent instruction, expert teachers also need to know how to teach in general, which is named pedagogical knowledge (Shulman, 1986). Keeping students engaged and checking their progress are examples of pedagogical knowledge. In addition to both content and pedagogical knowledge, expert teachers have so-called pedagogical content-specific knowledge: integrated knowledge of what and how to teach for a specific topic (Shulman, 1986). Pedagogical content-specific knowledge includes how to teach (e.g. offering an interesting case) certain students (e.g. average 9th graders) about a topic (e.g. proportion). This knowledge is an integration of teaching and content.

Finally, expert teachers need practical knowledge—knowledge of how to practice teaching in a certain social context (Sternberg & Horvath, 1995). For example, teachers have to know most parents' expectation about their kids' education and how to ask parents'

cooperation.

Teachers' knowledge base is composed of two styles of memory, conceptual and procedural (E. Gagne, Yeknovich, Yeknovich, 1993; Anderson, 1992). Facts, concepts, principles, and theories about instruction are stored in conceptual memory in forms of propositions, images, scripts, linear ordering, or schema. To teach effectively, conceptual memory must be related to appropriate teaching actions and behaviors that are stored in procedural memory.

Procedural memory can be separated into cognitive strategies and basic skills according to their possibility of automation. When a teacher answers an unusual question from a student, he or she may need to activate knowledge about that student's ability and weakness and then chooses a proper explanation that the student can understand. In doing so, the teacher is applying cognitive strategies. Cognitive strategies are solution strategies for complex problems that require mental effort or take several information into account at the same time. Even with heavy practice, most people hardly perform cognitive strategies quickly.

Automatic skills in instruction are procedures that teachers adopt in everyday classrooms, such as routines for collecting homework or calling the roll. Teachers may have practiced these skills hundreds or even thousands of times so that they waste little cognitive resources performing them. Once such a skill becomes automatic, people are hardly able to articulate how they do it.

Teachers' knowledge domains investigated by this study were limited to four knowledge domains: content knowledge, pedagogical knowledge, pedagogical content-specific knowledge, and practical knowledge.

Expert teachers' schematic knowledge about lesson planning has been studied intensively (Leinhardt & Greeno, 1986; Livingston & Borko, 1989; Borko & Linvingston, 1989; Westerman, 1991). In planning a lesson, teachers must integrate above four kinds of knowledge. Experts show less time-consuming and more efficient planning. Their plans are more adaptive to students' specific needs. Even when they attend to some students' needs they smoothly switch back to the original plan.

Research on expert novice-difference and teacher knowledge indicated that experts and novices differ not only in the amount of knowledge they have but also in the manner that knowledge is organized in memory. Along with expertise growth, many excellent teachers may develop various teaching styles and knowledge. This is especially true when one looks into how different the winners of teaching awards are. Expert teachers may use a wide range of teaching or managing methods in teaching any subject area to different levels of students. During implementation, expert teachers may flexibly decide to use some other alternatives cued by situations. All these factors increase the difficulty to capture the fuzzy nature of experts' knowledge.

Prototype of Teacher Expertise

Sternberg and Horvath (1995) indicated that the category-prototype model helps to describe fuzzy nature of teachers' knowledge. In their view, expert teachers' knowledge can be treated as the prototype, a best description, of teaching expertise.

One may consider that jars, plates, pots, and cups fit in the same category, say, food containers. Members in a category have some variation but still form a resemblance. As in the case of jars and plates, they share features such as being made of pottery, china, or plastic, are flat on bottom, are for serving food, etc. Rosch (1978) proposed that a

prototype or the central example of a category is whatever possesses a best summary for all the other members (see Figure 1). When a new stimulus comes in, people assign it to one of the relevant category in memory. Because prototype is the typical member so that categorization is a process of comparing the similarity of the prototype of each relevant category (Ashby & Maddox, 1998).

Social cognition research has addressed memory category with each person as an individual unit encompassing various features (Fiske & Taylor, 1991). If we organize memory about teacher with individual teacher as a member of the category, it is called person schema (in Figure 1). One can organize teachers along a continuum of expertise development, with novices at one end and experts at the other. Expert teachers though with some variation (in personality, teaching, and management styles) can be thought of as central members in this person schema, whereas novices are in the periphery. Similarly, in organizing teacher knowledge category (called expertise schema), it is reasonable to treat expert teachers' knowledge as the prototype while novices' as less representative exemplars.

Figure 1 shows both teachers' person schema and expertise schema. The left concentric is the person schema for teachers. The novices are the most remote members in the category, whereas the intermediate teachers are exemplars located around the central. The experts can be thought of as the central prototype (best exemplar) of the category. The right concentric shows teachers' knowledge schema. The experts' knowledge in the central contains more components, but because of being well organized it shows in a more condense (cohesive) way. The novices' knowledge is both poor in quantity and quality. Novice knowledge exemplars in the peripheral circle illustrate that they are the worst representation for teaching expertise. To capture the fuzzy nature described in Sternberg & Horvath (1985) each circle in two models is drawn with dot line.

This study intended to explore teachers expertise schema based on the category-prototype model. More specifically, is it appropriate to treat expert teachers' knowledge as the prototype of teaching expertise? Is the concentric of knowledge schema in figure 1 an appropriate model to represent teaching expertise?

Insert Figure 1 here

Methodology

Participants

All participants were mathematics in-service or pre-service teachers. Novices in this study were six pre-service teachers, currently taking teacher education programs at two research universities in Northern Taiwan. They all maintained outstanding achievement both in the major departments and teacher education programs. The beginners were four outstanding student teachers in their first year of student teaching, who graduated from the same universities. Three expert teachers with average 12.6 years of teaching were recommended by professors of teacher education programs through observations of their instruction. They either have served as senior teaching consultants in school district or chairs of math teacher committee in local school. All of them have previously been cooperative teachers for some student teachers, though not necessarily for the beginners in

the present study.

Procedures

One chapter period of a junior high math class was videotaped by two camcorders for a whole week. Six tapes were selected and edited into 128 digital slides, later displayed by Microsoft PowerPoint to the participants. These slides represented consecutive events of a normal math class including presentation of content, interaction among the teacher and students and within students groups, and involvement of students.

In the first phase, participants from any of three groups were shown slides and asked to freely comment. The participants could stop the slides whenever they wished to comment and their questions about classroom events were answered by the interviewers. The average length for the think-out-loud procedures for 13 participants was 74 minutes. In the second phase, the participants were asked to draw a general summary on what they had seen. They responded to questions about lesson contents and structures, task orientation, instructional variety, classroom management, learning climates, individual student behaviors, teacher roles, classroom context, issues related to general educational systems, and issues related to community-school interaction. The answers were added to the protocols for further analysis.

Data Analysis

Participants' comments were taped by a recorder and transcribed for further analysis. In this study the participants' comments were treated as active knowledge (can be articulated) to reveal their teaching expertise schema.

The two coding systems were modified from Carter, et al., (1988) and Borich (1994). The first system, content of comments, contained eleven domains: lesson content and structure, task orientation, instructional variety, classroom management, learning climate, student outcome, teacher role, classroom context, issue related to general education system, issue related to community-school interaction, and other. These ten domains describing various aspects of instruction are listed in the below.

1. Lesson Content and Structure: The concepts, topics, or tasks that are taught by the teacher or anything related to textbook selection, prior knowledge, and mathematics issues.

2. Task Orientation: The teacher uses certain major systematic instructional strategies, e.g. review, explanation, demonstration, seatwork practice, checking, and feedback.

3. Instructional Variety: The teacher adopts some supportive instructional strategies, e.g. changing voice inflection, body movement, or eye contact to draw students' engagement, sometimes using activities to enhance problem solving, or allocating of instructional time.

4. Classroom Management: The management rules or routines, e.g. minimize any interruptions or problematic behaviors, collect homework, or speed activity transition, that are used by the teacher.

5. Learning Climate: The patterns of teacher-student interactions show in the instructional events, e.g. degree to which students can express their feeling and opinion, teacher allowance of sharing and discussion among students, or teacher expectation and influence.

6. Student Outcome: Students' background, participation, performance, learning related traits, or possible thinking process show in the instructional events.

7. Teacher Role: The teachers' background, training, professional development, or possible thinking process show in the instructional events.

8. Classroom Context: Classroom arrangements display in the slides, e.g. decoration, seating arrangement, location of equipment, or weather.

9. Issue Related to General Education System: The ways the general education system influence students, teachers, or classroom teaching, e.g. how a newly implemented entrance examination policy changes instruction.

10. Issue Related to Community-School Interaction: The ways the resources, people, or policies of community influence school, e.g. interaction among teachers and parents.

11. Others: Anything that can not be coded into above ten domains goes to this category.

Second, the nature of comments included six levels: question, description, interpretation, evaluation, conclusion, and suggestion. These six levels regarding various cognitive processing about instruction are stated in the following.

1. Question: The participants ask any question about people, objects, or events in the slides. For example, "Is that the textbook they use?"

2. Description: The participants plainly describe what is seen with no further inference. For example, "The class just begins. Students come into the classroom slowly."

3. Interpretation: The participants explain or infer the instructional events based on his or her prior knowledge. For example, "In such situation, it looks like the teacher is asking a more capable student to write the proof on the blackboard."

4. Evaluation: The participants judge or value, such as good or bad, what is seen. For example, in the slides the teacher asks how many students answer correctly in a problem; "I don't think this checking routine is effective. As a student, I would be too shy to raise my hand admitting that I am smart."

5. Conclusion: The participants summary or synthesize what was seen previously into a relatively complete concept or theme. Such as, "The teacher has demonstrated the principle of square root and solved some typical problems. Ok, I see. This is a math class of 9th grade."

6. Suggestion: The participants suggest the ways to modify or alter instruction or management. For example, "I don't do this. In order to check students' learning, I assign seatwork and walk slowly to see how they perform."

The authors and a trained research assistant with master degree in Mathematics coded the protocols. In the coding process, there were several refined cycles to split or combine domains/levels for accurately representing the data. In the first run, two researchers coded each sentence independently. One hundred sentences were randomly selected from all protocols to analyze coding agreement between two researchers. The coding agreement was defined as the percentage of coding-agreed sentences in one hundred sentences. For the first coding system, content of comments, 81 sentences were coded into the same domains, so the coding agreement was 0.81. For the second coding system, nature of comments, coding agreement was 0.94. In the second run, those sentences that were coded into different domains or levels were discussed until an agreement was reached.

For the quantitative analysis, descriptive statistics were adopted to analyze each teacher's comment frequencies according to each coding system. In the content analysis of think-out-loud protocols, the unit of analysis is not person but statements, so Chi square analyses were appropriate to be used in examining the differences of comment frequencies. Independent to the quantitative analysis, a qualitative analysis was performed. After several rounds of coding, the protocols were read again to form several tentative descriptions about teachers' instructional knowledge. Propositions 1, 2, and 3 were identified by both coders. The decision to include qualitative descriptions about teachers'

expertise was made because of the richness of the detail in participants' comments and for a full understanding about differences between groups of subjects.

Research Questions

The current study intended to explore the following research questions.

1. Do expert, beginning, and novice teachers differ in the amounts of instructional knowledge? Do they possess various amounts of instructional knowledge in different knowledge domains?

2. Are there substantial differences between knowledge of experts, beginners, and novice?

3. Do expert, beginning, and novice teachers differ in their levels of processing teaching events?

4. How to describe the prototype (experts' instructional knowledge) of the teaching expertise model qualitatively?

Results and Discussions

The quantitative and qualitative findings of this study have been summarized as the answers to the four research questions. The small amount of participants in this exploratory study limits the generalizability of the results to other populations and settings. Therefore, the current results should be treated with cautious.

1. Expert teachers possessed more knowledge than beginning and novice teachers. Moreover, in most domains (instruction aspects) experts expressed more knowledge than others.

Average frequencies of comments expressed by expert, beginning, and novice teachers were 447, 273.9, and 183.8. In other words, viewing one slide they made 3.49, 2.14, and 1.44 statements respectively. Differences were obvious not only between experts and novices (174 pieces of comments) but also between experts and beginners (90 pieces of comments).

Teachers' knowledge were categorized into 10 domains, i.e. Task Orientation, Lesson Content and Structure, Student Outcome, Classroom Management, Teacher Role, Education System, Classroom Context, Learning Climate, Instructional Variety, and Community-School Relationship. Table 1 shows summary of Chi-square analysis for expert, beginning, and novice teachers and their various amounts of domain knowledge. In general, novices, beginners, and experts expressed significantly different amounts of knowledge in various instructional domains ($X^2 = 70.24$, $df = 14$, $p < .001$). Experts possessed more contents in most knowledge domains, except Classroom Management, Learning Climate, and Instructional Variety.

Insert Table 1 here

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2. There existed substantial differences between knowledge of experts, beginners, and novice.

In Table 1, the gray cells containing standardized residuals greater than 2 were major contributors to the significant Chi square values (Hinkle, Wiersma, & Jurs, (1988) suggests). For expert teachers, while Student Outcome domain was richer than those of novices and beginners, theirs Classroom Management and Learning Climate domains were relatively smaller than expected. Comparing with novices and experts, beginning teachers expressed more about Classroom Management domain. For novices, Student Outcome and Education System domains were much poor than expected.

Figure 2 illustrates frequencies of knowledge categorized into ten domains for the three groups of teachers. For all teachers, the domains of Task Orientation and Lesson Content/Structure were the most frequently expressed knowledge. Student Outcome was the third frequently mentioned domain for expert teachers, while for beginners and novices, Classroom Management domain. Expert teachers' knowledge broadly distributed along 10 domains, whereas novices' knowledge fell into few most frequently mentioned domains. Novice did not express anything that can be categorized into School-Community Relationship domain. Besides, their Educational System and Classroom Context domains had very few, if not empty, elements.

Insert Figure 2 here

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3. Do expert, beginning, and novice teachers differ in their processing levels of teaching events?

Teachers' comments were categorized into six levels of processing, from shallow to deep processing, i.e. Questioning, Description, Interpretation, Evaluation, Conclusion, and Suggestion. The Chi-square analysis demonstrated that three groups of teachers expressed their instructional knowledge through significant different levels of processing ($X^2 = 160.57$, $df = 10$, $p < .001$, in Table 2).

Insert Table 2 here

For expert teachers the most frequently used processing level was Evaluation and then Suggestion. The amounts in these two domains were relatively huge, for example 176.3 in Evaluation domain which was almost equal to the whole amount of novices' active instructional knowledge, 183.8. In other words, experts spontaneously made value judgment about instructional practices or the instructional stimuli activated their huge base of teaching and management strategies and procedures.

For beginning and novice teachers, they were more likely to use lower level processing skills. Basically, their knowledge was expressed by simple Description of visual stimuli. They were also less capable to use higher level processing skills, such as Evaluation and

Suggestion in addressing instructional knowledge. This finding is congruent with the results of Saber, Cushing, & Berliner. (1991). Several reasons may explain why they cannot make Suggestion as much as those of experts. Novice may have poor quality of cognitive structure, less automatic skills, less real situation practice, and probably even lower confidence.

4. The qualitative description about the teaching expertise model and its prototype.

Using qualitative analysis, three propositions were formed to describe teachers' teaching expertise.

Proposition 1. **All teachers in different stages of expertise expressed very few about decisions, procedures, and importance of lesson planning.** This finding is not compatible with the description about how and what American teachers perform dedicated lesson planning from the previous research in the United States (Leinhardt & Greeno, 1986; Livingston & Borko, 1989; Borko & Linvingston, 1989; Westerman, 1991). We attributed this difference to the adoption of a unified national curricula, teacher guides, and textbooks by Taiwan educational system. Teachers in Taiwan are not required to construct lessons by their own but rather have to follow restrictedly curricula; otherwise it may provoke administrators or parents' monitor. The very reason was for the concern of students' achievement in unified entrance examination.

Proposition 2. **Only expert teachers have integrated all kinds of knowledge to form multi-path instructional strategies to deal with individual differences or situational differences**. Reexamining the related statements, it was especially obvious that these instructional strategies were expressed in the format of if-then decision tree and often being categorized into processing level of Suggestion. Typically, experts might attend to certain events or persons in the slides as the start points; then they went further beyond description or simple interpretation about reality. Based only their teaching experiences, expert teachers made assumptions about people (e.g. possible personalities or attitudes of students, parents, and colleagues) and problems (e.g. possible reactions from people or students' weakness in learning the tasks) and offered several step-by-step strategies to deal with complex challenges. This nature of experts' comments may account for the difficult the researchers met in coding experts' protocols. In fact, most disagreement in coding analysis occurred in categorizing experts' statements.

Such feature of experts' knowledge did not show in beginners who were experiencing student teaching. Therefore, it is reasonable to infer that the composition of all aspects of instructional knowledge did not occurred in early years of teaching. Through hundreds and thousands hours of practicing, teachers integrate weak-associated knowledge.

Proposition 3. **Experts' knowledge contained motivation aspect that particularly reflected positive personal teaching efficacy.** Experts show their confidence in every aspect of teaching practice, from subject matter preparation, instructional strategies, to classroom management or student teacher communication. Their comments about the actor teacher were predominately encouraging and understanding the struggle to get through to most difficult students. Whereas, novices' statements reflected their uncertainty in coming up with a strategy, less confidence about their suggestion of teaching practice, passive opinion about effects of teacher's efforts, and also more negative evaluation on what the teacher actors did in the slides.

Conclusions

The above quantitative and qualitative results help to sketch a more complete view for teachers' instructional knowledge which is visually presented by modifying expertise schema of Figure 1 into the model of Figure 4.

Previous findings that experts' instructional knowledge is richer and broader (e.g., Carter, Sabers, Cushing, Pinnegar, & Berliner, 1987; Swanson, O'Connor, & Cooney, 1990) was confirmed. Therefore, to treat expert teachers' knowledge as the prototype is adequate based on Sternberg & Horvath's (1995) rationale and current evidences.

Second, novice, beginning, and expert teachers contain significantly different patterns of instructional knowledge. Therefore in Figure 1, it is reasonable to change the each dot line circle into circles of solid line. Third, no matter how mature is a teacher's expertise, he/she possesses almost all kinds of instructional knowledge domains, though only expert teachers build a comprehensive knowledge base. Thus, more similar icons, than those in Figure 1, are used to represent novices, intermediators, and experts' knowledge elements in the teaching expertise schema of Figure 4. The fuzzy nature of teaching expertise can not be thought of as osmosis effect between nearby areas or the gradual evolution from novices to intermediators and from intermediators to experts, but rather similarity of individual knowledge elements shared by all teachers.

Insert Figure 4 here

Fourth, knowledge of systematic instructional strategies occupies the largest space of experts' teaching expertise. Knowledge about subject matter contents and knowledge of student outcome also share a substantial proportion. Comparing with less mature teachers, knowledge about students' performance is a significant feature in expert teachers' expertise schema. Knowledge about classroom management and learning climate may once play an important role in the development of expertise, but in experts' schema the weights of these two domains has decreased. Novices' schema lacks knowledge about general education system.

Fifth, the supplemental qualitative analysis indicated that all teachers in Taiwan, no matter how mature are their expertise, hardly concern about decision, procedures, and importance of lesson planning. Expert teachers have experienced a compositional period to integrate all kinds of knowledge so they have formed multi-path instructional strategies to deal with individual differences or situational differences. Experts' knowledge contained motivational aspect that reflected their positive personal teaching efficacy. In general, expert teachers possess knowledge with better quality and well organization, so that the icons in the inner circle of Figures 4 are arranged to show hierarchy and strong association. Finally, experts' the comprehensive knowledge base makes higher level information processing with ease.

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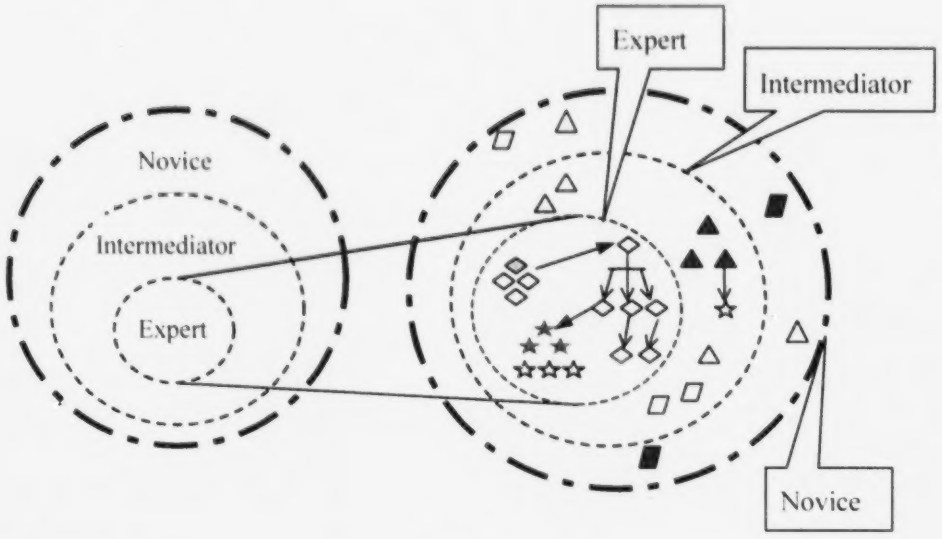

Figure 1: The left concentric is the person schema for teachers, while the right one shows teachers' knowledge schema.

Table 1: Contingency table of 10 knowledge domains in three groups of teachers.

Domain	Expert		Beginner		Novice		Total	Standardized Residuals		
	O	E	O	E	O	E		Expert	Beginner	Novice
Content	121.3	105.0	59.6	66.1	34.7	44.5	215.6	1.59	-0.80	-1.47
Task	138.7	154.1	97.7	97.0	80.0	65.3	316.4	-1.24	0.07	1.82
Variety	7.3	13.1	10.5	8.3	9.1	5.5	26.9	-1.60	0.78	1.51
Management	26.0	40.0	35.9	25.2	20.2	16.9	82.1	-2.21	2.14	0.79
Climate	12.3	25.0	22.8	15.8	16.3	10.6	51.4	-2.54	1.77	1.74
Student	76.3	53.5	23.5	33.7	10.0	22.7	109.8	3.12	-1.75	-2.66
Teacher	25.7	21.7	7.5	13.6	11.3	9.2	44.5	0.87	-1.66	0.70
System	22.7	18.0	13.5	11.3	0.7	7.6	36.9	1.12	0.65	-2.51
Total	430.3		271		182.3		883.6			
X^2=70.24	DF = (8-1) (3-1) =14				P < .001					

- Most frequencies on the domains of classroom context and school-community for three groups of teachers were lower than 5, so theses two domains were excluded for Chi-square analysis.
- O: observed frequencies. E: expected frequencies.

Table2: Contingency table of 6 processing levels in three groups of teachers.

Processing Level	Novice		Beginner		Expert		Total	Standardized Residuals		
	O	E	O	E	O	E		Expert	Beginner	Novice
Questioning	22.0	17.7	21.0	26.4	44.3	43.1	87.3	0.18	-1.06	1.01
Description	51.5	34.0	93.3	50.7	22.7	82.8	167.5	-6.60	5.98	2.99
Interpretation	35.2	29.4	57.0	43.9	52.7	71.6	144.9	-2.23	1.98	1.06
Evaluation	40.6	52.5	41.4	78.2	176.3	127.6	258.3	4.31	-4.16	-1.64
Conclusion	8.3	7.2	12.8	10.7	14.3	17.5	35.4	-0.76	0.64	0.41
Suggestion	26.2	42.9	48.4	64.0	136.7	104.4	211.3	3.16	-1.95	-2.55
Total	183.8		273.9		447		904.7			
X^2=160.57	DF = (6-1) (3-1) =10				P < .001					

- O: observed frequencies. E: expected frequencies.

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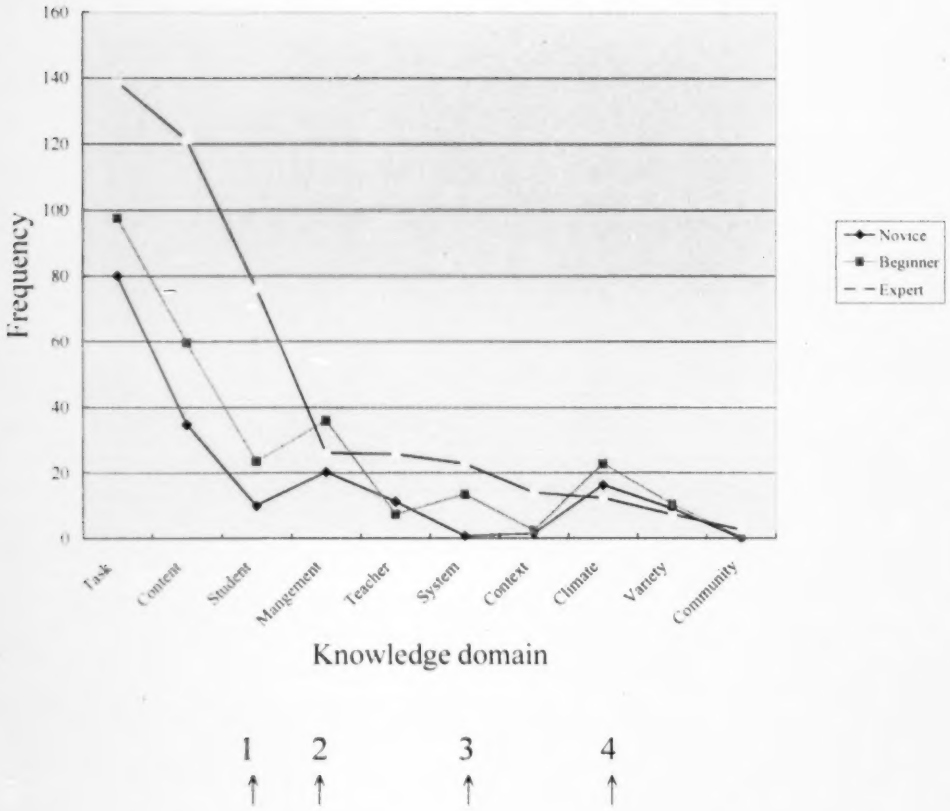

1: In Student Outcome domain, expert teachers possessed richer knowledge than novices and beginners, while novices expressed less than expected.
2: In Classroom Management domain, beginners expressed more than experts.
3. Novices possessed very few, if any, knowledge in the domain of Education System.
4. In Learning Climate domain, experts expressed less than expected.

Figure 2: Frequencies of knowledge in ten domains among novice, beginning, and expert teachers.

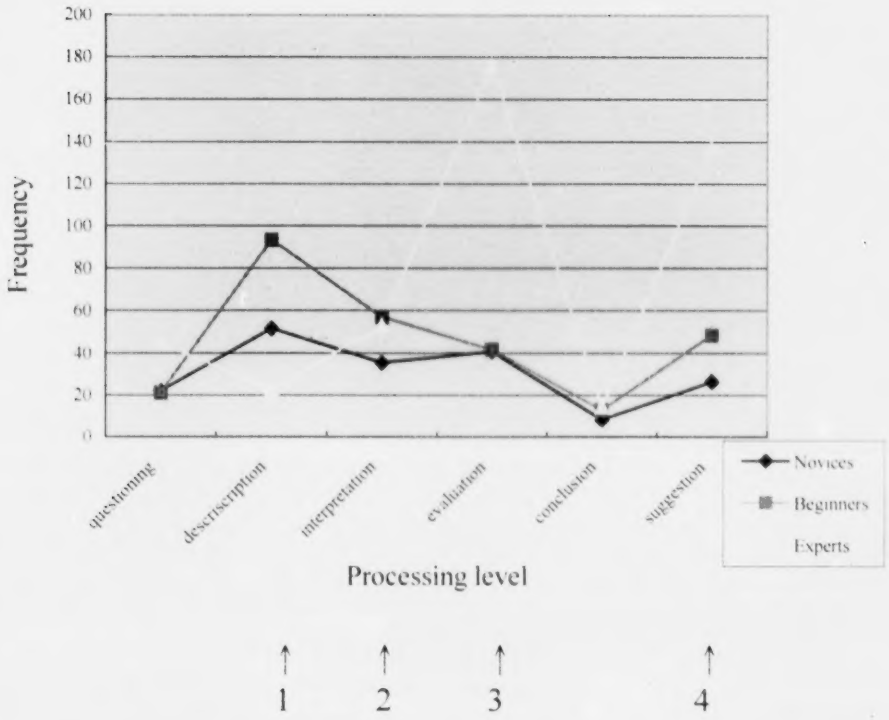

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Figure 3: Frequencies of knowledge categorized into six processing levels among novice, beginning, and expert teachers.

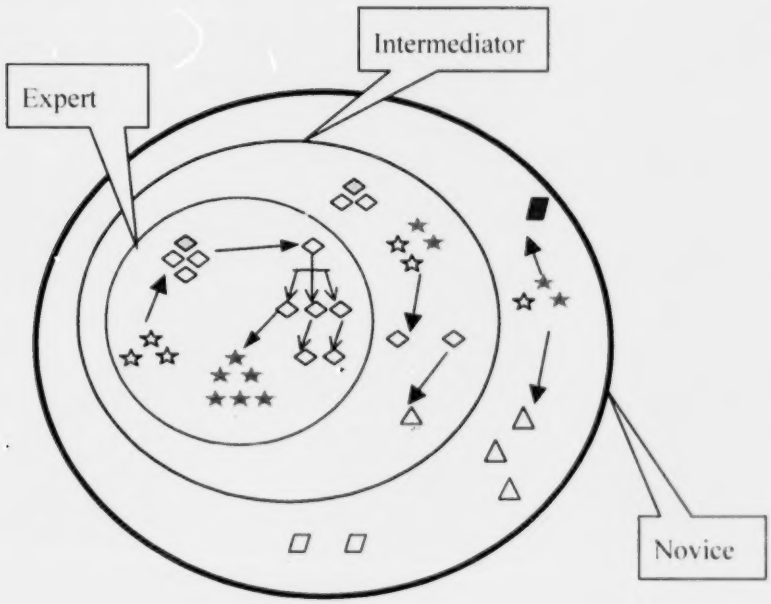

Figure 4: The new teaching expertise schema supported by the results of the current study. The border of each circle is replaced by solid line to show significant expertise differences between novices, intermediators, and experts. The icons to represent knowledge elements have been changed to show more similarities shared by all teachers. However, experts' knowledge displays a highest degree of organization and association. Please add you name and affiliation